NUCLEAR ENERGY RESEARCH INITIATIVE

Engineering and Physics Optimization of Breed & Burn Fast Reactor Systems

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The term "breed & burn" (B&B) is used to refer to fast reactors in which reload fuel has a significantly lower enrichment than that required to sustain criticality. The deficit is made up by breeding new fissile material in the fresh fuel faster than its depletion in the older fuel in the core. In the ideal case, only depleted uranium make-up is required in the steady state, and no reprocessing is required. The most compelling attribute of B&B systems is their virtual guarantee of sustainability via significantly better utilization of uranium resources. The concept is found in the NERI field of endeavor F-1: "Nuclear Engineering-Advanced Nuclear Energy Systems," where Generation IV goals are addressed and summarized in Table 1. B&B is not an entirely new concept, although only a handful of investigators have published on this topic since it was first mentioned in 1958 by the Russian physicist, Feinberg. Moreover, the emphasis to date has been almost entirely on reactor physics. Complicated fuel shuffling schemes have been suggested, including temporary introduction of a moderator, and fuel in-core residence times in excess of 100 years (!) were put forward uncritically in this prior work.

The present proposal will determine the feasibility of achieving significant B&B benefits in practical plant designs. These will likely be based on gas coolant and carbide or metal fuel, to avoid introducing too much moderation, which spoils the ultra-hard spectra needed by this concept. High power density is also needed to accelerate fuel throughput and move quickly to an equilibrium fuel cycle. Overall project coordination will be provided by MIT; INEEL and ANL-WEST will contribute significantly in their areas of special expertise and in collaborative work on shared tasks.